СЕКЦИЯ ФИЗИКОХИМИИ ПОЛИМЕРНЫХ И КОЛЛОИДНЫХ СИСТЕМ

CHARACTERIZATION OF FERROGELS AND MAGNETIC COMPOSITES BASED ON POLYACRYLAMIDE WITH EMBEDDED IRON OXIDE NANOPARTICLES

Scharf F.[(1)], *Mikhnevich E.A.*[(2)], *Safronov A.P.*[(2)]
[(1)] Technical University Dresden
01062, Dresden, Helmholtzstr. 10
[(2)] Ural Federal University
620002, Yekaterinburg, Mira, 19

Biocompatible ferrogels are the advanced materials, which gain attention both from the theory and from the viewpoint of prospective bio-medical application in actuators and biosensors. The ferrogel contains the polymeric network of a water soluble polymer, which provides its mechanical elasticity and the magnetic particles embedded in the network, which give the sensitivity of the material to the external magnetic field. The target properties of ferrogel such as mechanical ones are subjected by the complex combination of the molecular and interfacial interactions in its structure.

The objective of the present research was to study the interactions in the ferrogel based on polyacrylamide (PAAm) with embedded iron oxide (FeOx) magnetic nanoparticles (MNP) in respect to the selected mechanical and magnetic properties. Therefore two model systems: the suspension of FeOx in the solution of linear PAAm and the binary composite of linear PAAm and FeOx, were primarily considered.

First the adsorption of linear PAAm at the surface of MNPs was measured using the refractive index for the determination of the residual polymer concentration in the supernatant solution. It was found out that the adsorption of PAAm strongly depends on whether the suspension of MNPs is electrostatically stabilized or not. In the latter case the positive adsorption of PAAm onto FeOx MNPs was found with its maximum 9.4 mg of PAAm per 1g of FeOx at 1.35% in the supernatant solution. However, if sodium citrate (NaCit) was used as the electrostatic stabilizer of MNP suspension mixed with PAAm solution, the adsorption was found negative, which meant that PAAm macromolecules were repelled from FeOx surface.

The negative influence of NaCit on the interaction between PAAm and FeOx MNPs was also shown by measuring the enthalpy of interaction in binary composites PAAm/FeOx. Therefore, composite films with FeOx content 0 – 90% were cast from the mixed suspensions and the enthalpy of their dis-

solution in water was measured by means of Calvet microcalorimetry. The enthalpy of interaction at the PAAm/FeOx interface was calculated from these data using the appropriate thermochemical cycle. It was found out that the enthalpy of adhesion for the composites with no NaCit approached for saturation (-10 J/m²) for increasing concentrations of PAAm. The negative enthalpy shows that the adhesion is an energetically favourable process. If NaCit was involved in the composites the values of the enthalpy were positive and indicated that there was no adhesion.

Based on these results it was concluded that while ferrogels were synthesized by PAAm polymerization in the suspension of FeOx MNPs stabilized by NaCit, the latter efficiently prevented interaction between PAAm subchains of the network and the embedded MNPs. The synthesized ferrogels with the MNP content up to 3.8% by weight were subjected to the studies of the swelling degree, the Young modulus and the magnetostriction in 400mT uniform magnetic field.

It was shown that the swelling degree of the ferrogel is independent on the mass contents of MNP and lies around the value of 30. The Young modulus showed a behavior unforeseen by the theoretical expectations. Instead of the linear dependence on the volume fraction of MNPs it showed very steep increase to saturation at very low MNP content. Concerning the magnetostriction no effect could be measured. A theoretical approach showed that the MNPs were too small to be affected by the field at a given level of the modulus of gel.

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ВЛИЯНИЕ МАГНИТНОГО ПОЛЯ НА МЕХАНИЧЕСКИЕ СВОЙСТВА ПЛЕНОК ЦИАНЭТИЛЦЕЛЛЮЛОЗЫ

Абу Салех А.С., Русинова Е.В., Вшивков С.А.
Уральский федеральный университет
620002, г. Екатеринбург, ул. Мира, д. 19

Расширение областей применения и условий эксплуатации полимерных материалов, а также их незаменимость в большинстве изделий бытового и технического назначения требуют качественного исследования их механических свойств и, прежде всего, деформации при ползучести. Можно предположить, что величина и скорость ползучести полимерных пленок контролируются структурой пленок.

В этой связи представляет интерес исследование ползучести пленок полимеров, полученных в условиях магнитного поля, поскольку